CLAIMS

What is claimed is:

1. (Cancelled)

2. A method for computing the conformal structure of a surface, the method comprising:

receiving a first mesh representation M of said surface;

conformally mapping said mesh representation to a canonical parameter domain forming a first mapped surfaces; and

computing a conformal parameterization of said first mapped surface.

3. The method of claim 1 wherein the step of computing said conformal parameterization includes:

computing a homology basis $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ of said mesh representation, wherein computing said homology basis includes the steps of:

computing a set of boundary matrices ∂_1, ∂_2 for said mesh representation, respectively;

forming a matrix D, wherein $D = \partial_2\partial_2^T + \partial_1^T\partial_1$;

computing the Smith normal for said matrix D; and

computing the eigenvectors of D corresponding to zero eigenvalues that are equal to $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$, and wherein $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ are a homology basis of said mesh representation.

4. The method of claim 2 wherein the step of computing the conformal parameterization includes the step of computing a set of harmonic 1-form basis, wherein the step of computing said set of harmonic 1-form basis includes the steps of:

calculating the value of $c_i^j = -\gamma_i \bullet \gamma_j$, $i,j = 1, 2, \ldots, 2g$ wherein γ_i, γ_j is the homology basis of the mesh representation; and

solving the linear system $\delta\omega_i = 0$, $\Delta\omega_i = 0$, $\langle\omega_i, \gamma_j\rangle = -\gamma_i \bullet \gamma_j$ for ω_i, wherein $\{\omega_1, \omega_2, \ldots, \omega_{2g}\}$ is the desired harmonic 1-form basis of said mesh representation.

5. The method of claim 3 wherein the step of computing the conformal parameterization further includes the steps of:

computing the fundamental domain D_M of the mesh representation, wherein the step of computing the fundamental domain D_M of the mesh representation includes the steps of:

selecting an arbitrary face, $f_0 \in M$;

setting D_M to f_0;

setting $\partial D_M = \partial f_0$;

placing all neighboring faces of f_0 that share an edge with f_0 in a queue, Q;

while Q is not empty:

reading the first face in Q;

setting $\partial f = e_0 + e_1 + e_2$;

setting $D_M = D_M \cup f$;

finding the first $e_i \in \partial f$ such that $-e_i \in \partial D_M$;

replacing $-e_i$ in ∂D_M with $\{e_{(i+1)}, e_{(i+2)}\}$;

putting in Q all the neighboring faces that share an edge with f in the mesh representation and that are not in D_M or Q; and

removing all adjacent oriented edges in ∂D_M that are opposite each other in sign.

6. The method of claim 4 wherein the step of calculating said conformal parameterization of said first mapped surface further includes the steps of:

recording a first path δ from root vertex v_0 to u by traversing all the vertices $u \in D_M$;

computing the integration of $\phi(u) = <\omega, \gamma_u>$; and

providing as an output $\phi(u)$ as the conformal coordinates of u.

7. The method of claim 5, wherein the step of calculating said conformal parameterization of said first mapped surface further includes the step of calculating the cohomology basis, wherein the step of calculating the cohomology basis includes the steps of:

setting $\omega_i(e_i)=1$ and $\omega_i(e_j)=0$ for any edge $e \in T$;

ordering D_M such that $D_M = \{f_1, f_2, \ldots, f_n\}$;

reversing the order of D_M to $\{f_n, f_{n-1,}, \ldots, f_1\}$;

while D_M is not empty:

retrieving the first face f of D_M;

removing f from D_M, $\partial f = e_0 + e_1 + e_2$;

divide $\{e_k\}$ into two sets, $\Gamma = \{e \in \partial f \mid -e \in \partial D_M\}$, $\Pi = \{e \in \partial f \mid -e \notin \partial D_M\}$;

choosing the value of $\omega_i(e_k), e_k \in \Pi$ arbitrarily, such that $\sum_{e \in \Pi} \omega_i(e) = -\sum_{e \in \Gamma} \omega_i(e)$, and if Π is empty, then the right hand side is equal to zero;

updating the boundary of D_M, let $\partial D_M = \partial D_M + \partial f$; and

computing the dual of the homology basis, $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$, by the linear transform $\{\omega_1, \omega_2, \ldots, \omega_{2g}\}$ such that $<\gamma_i, \omega_j> = -\gamma_i \cdot \gamma_j$.

8. The method of claim 1, wherein the step of conformally mapping and calculating said conformal parameterization of said mesh representation includes the step of calculating the holomorophic 1-form, wherein the step of calculating the holomorphic 1-form includes the steps of:

computing the doubling of M, $\overline{M}$;

computing the harmonic 1-form basis of $\overline{M}$ $\{\omega_1, \omega_2, \ldots, \omega_{2g}\}$;

assigning $\tau_i = \frac{1}{2}(\omega + \overline{\omega})$ and removing redundant ones;

computing conjugate harmonic 1-forms of τ_i denoted as τ_i^*; and

outputting the holomorphic 1-form basis $\{\tau_1 + \sqrt{-1}\tau_1^*, \tau_2 + \sqrt{-1}\tau_2^*, \ldots, \tau_k + \sqrt{-1}\tau_k^*\}$.

9. The method of claim 7 wherein the step of doubling M to form $\overline{M}$ includes the steps of:

copying M, denoted as -M;

reversing the orientation of -M;

finding for each boundary vertex $u \in \partial M$, a unique corresponding boundary vertex $-u \in \partial -M$;

finding for any edge on $e \in \partial M$ a unique boundary edge $-e \in \partial -M$; and

gluing M and -M such that the corresponding vertices and edges are identical, wherein the resulting mesh is the doubling $\overline{M}$.

10. The method of claim 7 wherein the step of calculating said conformal parameterization of said mesh representation, M, further includes the step of calculating a conformal structure, wherein the step of calculating the conformal structure includes the steps of:

a) providing the holomorphic 1-form basis $\{\tau_i + \sqrt{-1}\tau_i^*\}$;

b) computing a partition $\{U_i\}$, such that $M \subset U_i$, U_i being simply connected;

c) for each U_i, selecting a holomorphic 1-form base $\omega_j + \sqrt{-1}\omega_j^*$;

d) integrating the holomorphic 1-form on U_i, denoting the mapping as z_i, and in the event that there are zero points, subdivide U_i and repeat the integration; and

e) outputting the conformal structure $\{(U_i, z_i)\}$.

11. The method of claim 4 wherein the step of calculating said conformal parameterization of said mesh representation further includes the step of calculating the period matrices, wherein the step of calculating the period matrices includes the steps of:

calculating the elements of a matrix C as $c_{ij} = \langle\gamma_i, \omega_j\rangle$;

calculating the elements of a matrix S as $s_{ij} = \langle\gamma_i, \omega_j^*\rangle$; and

calculating the matrix R as the solution of CR = S where R satisfies $R^2 = -I$, where I is the identity matrix.

12. A method for classifying a surface, the method comprising the steps of:

receiving a mesh representation of the surface;

computing a period matrix R corresponding to said mesh representation of the surface; and

storing said period matrix R.

13. The method of claim 11 wherein the step of computing said period matrix R includes the steps of:

computing a homology basis $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ of said mesh representation, wherein computing said homology basis includes the steps of:

computing a boundary matrix ∂_1, ∂_2 for said mesh representation;

forming a matrix D, wherein $D = \partial_2 \partial_2^T + \partial_1^T \partial_1$;

computing the Smith normal for said matrix D; and

computing the eigenvectors of D corresponding to zero eigenvalues that are equal to $\{\gamma_1, \gamma_2, \dots, \gamma_{2g}\}$ wherein $\{\gamma_1, \gamma_2, \dots, \gamma_{2g}\}$ are a homology basis of said mesh representation.

14. The method of claim 12 wherein the step of calculating said period matrix R further includes the step of computing a set of harmonic 1-form basis, wherein the step of computing said set of harmonic 1-form basis includes the steps of:

calculating the value of $c_i^j = -\gamma_i \bullet \gamma_j$, $i,j = 1, 2, \dots, 2g$, wherein γ_i, γ_j are the homology basis of the mesh representation; and

solving the linear system $\delta\omega_i = 0$, $\Delta\omega_i = 0$, $\langle\omega_i, \gamma_j\rangle = -\gamma_i \bullet \gamma_j$ for ω_i, wherein $\{\omega_1, \omega_2, \dots, \omega_{2g}\}$ is the desired harmonic 1-form basis of the mesh representation.

15. The method of claim 13 wherein the step of computing said period matrix R further includes:

calculating the elements of a matrix C as $c_{ij} = \langle\gamma_i, \omega_j\rangle$;

calculating the elements of a matrix S as $s_{ij} = \langle\gamma_i, \omega_j^*\rangle$; and

calculating the period matrix R as the solution of $CR = S$ where R satisfies $R^2 = -I$, where I is the identity matrix.

16. A method for matching first and second surfaces, the method comprising:

receiving first and second mesh representations of said first and second surfaces, respectively;

conformally mapping both of said first and second mesh representations to a first canonical parameter domain, thereby forming first and second mapped surfaces;

computing first and second conformal parameterizations of said first and second mapped surfaces, respectively;

computing first and second level sets of Gaussian curvature and mean curvature for said first and second mapped surfaces, respectively, wherein said first and second level sets of Gaussian curvature and mean curvature are a function of said first and second conformal parameterizations, respectively; and

comparing said first and second level sets of Gaussian curvature and mean curvature and in the event that the comparison exceeds a predetermined threshold, declare a match between said first and second surfaces, otherwise declare a mismatch between said first and second surfaces.

17. The method of claim 15 wherein the step of computing said first and second conformal parameterizations includes the step of:

computing a homology basis $\{\gamma_{11}, \gamma_{12}, \ldots, \gamma_{12g}\}$ and $\{\gamma_{21}, \gamma_{22}, \ldots, \gamma_{22g}\}$ of said first and second mesh representations, respectively, wherein computing said homology basis includes the steps of:

computing first and second sets of first and second boundary matrices ∂_{11}, ∂_{12} and ∂_{21}, ∂_{22} for said first and second mesh representations, respectively;

forming first and second matrices D_1 and D_2, respectively, wherein $D_1 = \partial_{12}\partial_{12}^T + \partial_{11}^T\partial_{11}$ and $D_2 = \partial_{22}\partial_{22}^T + \partial_{21}^T\partial_{21}$;

computing the Smith normal for said matrices D_1 and D_2; and

computing the eigenvectors of D1 and D2 corresponding to zero eigenvalues that are equal to $\{\gamma_{11}, \gamma_{12}, \dots, \gamma_{12g}\}$ and $\{\gamma_{21}, \gamma_{22}, \dots, \gamma_{22g}\}$ wherein $\{\gamma_{x1}, \gamma_{x2}, \dots, \gamma_{x2g}\}$ are a homology basis of said first and second mesh representations, respectively.

18. The method of claim 16 wherein the step of computing said first and second conformal parameterizations further includes the step of computing a first and second set of harmonic 1-form basis, wherein the step of computing said first and second set of harmonic 1-form basis includes the steps of:

calculating the value of $c_{1i}^{j} = -\gamma_{1i} \bullet \gamma_{1j}$, ij = 1, 2, … , 2g and $c_{2i}^{j} = -\gamma_{2i} \bullet \gamma_{2j}$, i,j = 1, 2, … , 2g wherein γ_{1i}, γ_{1j} and γ_{2i}, γ_{2j} are the homology basis of the first and second mesh representations, respectively;

solving the linear system $\delta\omega_{1i} = 0$, $\Delta\omega_{1i} = 0$, $\langle\omega_{1i}, \gamma_{1j}\rangle = -\gamma_{1i} \bullet \gamma_{1j}$ for ω_{1i}, wherein $\{\omega_{11}, \omega_{12}, \dots, \omega_{12g}\}$ is the desired harmonic 1-form basis of the first mesh representation; and

solving the linear system $\delta\omega_{2i} = 0$, $\Delta\omega_{2i}=0$, $\langle\omega_{2i}, \gamma_{2j}\rangle = -\gamma_{2i} \bullet \gamma_{2j}$ for ω_{2i}, wherein $\{\omega_{21}, \omega_{22}, \dots, \omega_{22g}\}$ is the desired harmonic 1-form basis of the second mesh representation.

19. The method of claim 17 wherein the step of computing said first and second conformal parameterizations further includes the step of computing the fundamental domain D_{1M} and D_{2M} of the first and second mesh representations respectively, wherein the step of computing the fundamental domain D_{1M} and D_{2M} of the first and second mesh representations respectively includes the steps of:

selecting an arbitrary face, $f_{10} \in M_1$ and $f_{20} \in M_2$, and set D_{1M} and D_{2M} to f_{10} and f_{20} respectively;

setting $\partial D_{1m} = \partial f_{10}$ and $\partial D_{2m} = \partial f_{20}$;

placing all neighboring faces of f_{10} and f_{20} that share an edge with f_{10} and f_{20} respectively in a queue, Q_1 and Q_2, respectively;

while Q_1 and Q_2 are not empty:

reading the first face in Q_1 and Q_2;

setting $\partial f_1 = e_{10} + e_{11} + e_{12}$;

setting $D_{1M} = D_{1M} \cup f_1$;

finding the first $e_{1i} \in \partial f_1$ such that $-e_{1i} \in \partial D_{1M}$;

replacing $-e_{1i}$ and $-e_{2i}$ in ∂D_{1M} and ∂D_{2M}, respectively, with $\{e_{1(i+1)}, e_{1(i+2)}\}$ and $\{e_{2(i+1)}, e_{2(i+2)}\}$, respectively;

putting all the neighboring faces that share an edge with f_1 and f_2 in the first and second mesh representations, respectively, and that are not in D_{1M} and Q_1 and D_{2M} and Q_2, respectively, into Q_1 and Q_2, respectively; and

removing all adjacent oriented edges in ∂D_{1M} and ∂D_{2M} that are opposite each other in sign.

20. The method of claim 15 wherein said first and second surfaces are human faces.

21. The method of claim 15 wherein said canonical parameter domain is a disk.

22. A method for recognizing a surface represented by a mesh representation, M, the method comprising the steps of:

receiving the mesh representation of the surface;

removing at least one feature point from the mesh representation;

doubling the mesh representation, M;

computing the period matrix, R, for the mesh representation, M, having at least one feature point removed;

comparing the period matrix, R, corresponding to the mesh representation with at least one standard period matrix corresponding to a standard surface;

in the event that the period matrix, R, corresponding to the mesh representation and the at least one standard period matrix corresponding to a standard surface are within a predetermined factor of one another, providing indicia that the surface represented by the mesh representation is recognized as being substantially similar to the at least one standard surface.

23. The method of claim 21, wherein the step of doubling the mesh representation, M, includes the steps of:

copying M, denoted as -M;

reversing the orientation of -M;

finding for each boundary vertex $u \in \partial M$ a unique corresponding boundary vertex $-u \in \partial -M$;

finding for any edge on $e \in \partial M$ a unique boundary edge $-e \in \partial -M$; and

gluing M and -M such that the corresponding vertices and edges are identical, wherein the resulting mesh is the doubling $\overline{M}$.

24. The method of claim 21, wherein the step of computing the period matrix R includes the steps of:

computing a homology basis $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ of said mesh representations, wherein computing said homology basis includes the steps of:

computing a set of boundary matrices ∂_1, ∂_2 for said mesh representations;

forming a matrix D, wherein $D = \partial_2\partial_2^T + \partial_1^T\partial_1$;

computing the Smith normal for said matrix D; and

computing the eigenvectors of D corresponding to zero eigenvalues that are equal to $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ wherein $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ are a homology basis of said mesh representation.

25. The method of claim 23 wherein the step of calculating said period matrix R further includes the step of computing a set of harmonic 1-form basis, wherein the step of computing said set of harmonic 1-form basis includes the steps of:

calculating the value of $c_i^j = -\gamma_i \bullet \gamma_j$, $i,j = 1, 2, \ldots, 2g$, wherein γ_i, γ_j are the homology basis of the mesh representation; and

solving the linear system $\delta\omega_i = 0$, $\Delta\omega_i = 0$, $\langle\omega_i, \gamma_j\rangle = -\gamma_i \bullet \gamma_j$ for ω_i, wherein $\{\omega_1, \omega_2, \ldots, \omega_{2g}\}$ is the desired harmonic 1-form basis of the mesh representation.

26. The method of claim 24 wherein the step of computing said period matrix R further includes:

calculating the elements of a matrix C as $c_{ij} = \langle\gamma_i, \omega_j\rangle$;

calculating the elements of a matrix S as $s_{ij} = \langle\gamma_i, \omega_j^*\rangle$; and

calculating the matrix R as the solution of CR = S where R satisfies $R^2 = -I$, where I is the identity matrix.

27. A method for recognizing a surface represented by a mesh representation, M, the method comprising the steps of:

receiving the mesh representation of the surface;

removing substantially all feature points from the mesh representation;

selecting an arbitrary point on the surface of the mesh representation, M;

selecting an arbitrary orbit along the surface of the mesh representation, M, for the arbitrary point to follow;

moving the arbitrary point along the arbitrary orbit;

removing the arbitrary point from the mesh representation, M, at at least one point along the arbitrary orbit;

doubling the mesh representation, M, having all feature points removed and the arbitrary point removed;

computing at least one period matrix, R, for the mesh representation having the arbitrary point removed;

comparing the at least one period matrix, R, corresponding to the mesh representation with at least one standard period matrix corresponding to a standard surface; and

in the event that the period matrix, R, corresponding to the mesh representation and the at least one standard period matrix corresponding to a standard surface are within a predetermined factor of one another, providing indicia that the surface represented by the mesh representation is recognized as being substantially similar to the at least one standard surface.

28. The method of claim 26, wherein the step of doubling the mesh representation, M, includes the steps of:

copying M, denoted as -M;

reversing the orientation of -M;

finding for each boundary vertex $u \in \partial M$, a unique corresponding boundary vertex $-u \in \partial -M$;

finding for any edge on $e \in \partial M$ a unique boundary edge $-e \in \partial -M$; and

gluing M and -M such that the corresponding vertices and edges are identical, wherein the resulting mesh is the doubling $\overline{M}$.

29. The method of claim 26, wherein the step of computing the period matrix R includes the steps of:

computing a homology basis $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ of said mesh representation, wherein computing said homology basis includes the steps of:

computing a boundary matrix ∂_1, ∂_2 for said mesh representation;

forming a matrix D, wherein $D = \partial_2\partial_2^T + \partial_1^T\partial_1$;

computing the Smith normal for said matrix D; and

computing the eigenvectors of D corresponding to zero eigenvalues that are equal to $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ wherein $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ are a homology basis of said mesh representation.

30. The method of claim 26 wherein the step of calculating said period matrix R further includes the step of computing a set of harmonic 1-form basis, wherein the step of computing said set of harmonic 1-form basis includes the steps of:

calculating the value of $c_i^j = -\gamma_i \bullet \gamma_j$, $i,j = 1, 2, \ldots, 2g$, wherein γ_i, γ_j are the homology basis of the mesh representation; and

solving the linear system $\delta\omega_i = 0$, $\Delta\omega_i = 0$, $\langle\omega_i, \gamma_j\rangle = -\gamma_i \bullet \gamma_j$ for ω_i, wherein $\{\omega_1, \omega_2, \ldots, \omega_{2g}\}$ is the desired harmonic 1-form basis of the mesh representation.

31. The method of claim 29 wherein the step of computing said period matrix R further includes:

calculating the elements of a matrix C as $c_{ij} = \langle\gamma_i, \omega_j\rangle$;

calculating the elements of a matrix S as $s_{ij} = \langle\gamma_i, \omega_j^*\rangle$; and

calculating the period matrix R as the solution of $CR = S$ where R satisfies $R^2 = -I$, where I is the identity matrix.

32. A method for compressing a mesh representation of a surface, the method comprising the steps of:

conformally mapping the mesh representation to a canonical shape;

representing the surface position vector on the canonical shape as a vector valued function;

finding the eigen functions of the Laplacian given by $\Delta\omega(u) = \sum_{[u,v]\in K_1} w_{[u,v]}\omega([u,v])$;

decomposing the vector valued function using the eigen functions of the Laplacian;

removing the high frequency components of the decomposed vector valued function; and

storing the low frequency components of the decomposed vector valued function as a compressed image of the mesh representation, M, of the surface.

33. The method of claim 31, wherein the surface is a genus-zero surface and the canonical shape is a sphere and wherein the step of conformally mapping the genus-zero surface to the sphere includes the following steps:

a) computing the Gauss map, mapping M to S^2;

b) computing the Laplacian at each vertex u of M, $\Delta\phi(u)$;

c) projecting $\Delta\phi(u)$ to the tangent space of $\phi(u) \in S^2$;

d) updating $\phi(u)$ along the negative projected $\Delta\phi(u)$;

e) computing the center of mass of $X\phi(u)$, $mc(\phi)$;

f) shifting the center of mass to the center of S^2;

g) renormalizing $\phi(u)$ to be on S^2; and

h) repeating steps b)-g) for all vertices, until the projected Laplacian equals zero.

34. The method of claim 32, wherein the Laplacian is $\Delta\omega(u) = \sum_{[u,v]\in K_1} w_{[u,v]}\omega([u,v])$.

35. A method for compressing a mesh representation, M, of a surface, the method comprising:

receiving the mesh representation;

conformally mapping mesh representation to a canonical parameter domain forming a mapped surface;

computing a conformal parameterization of said mapped surface;

computing a level set of Gaussian curvature and mean curvature for said mapped surface, wherein said level set of Gaussian curvature and mean curvature is a function of said conformal parameterization; and

storing said conformal parameterization of said mesh representation and said level set corresponding to said mesh representation.

36. The method of claim 34 wherein the step of computing said conformal parameterization includes the step of:

computing a homology basis $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ of said mesh representation, wherein computing said homology basis includes the steps of:

computing a set of first and second boundary matrices ∂_1, ∂_2 for said mesh representation;

forming a matrix D, wherein $D = \partial_2\partial_2^T + \partial_1^T\partial_1$;

computing the Smith normal for said matrix D; and

computing the eigenvectors of D corresponding to zero eigenvalues that are equal to $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ wherein $\{\gamma_1, \gamma_2, \ldots, \gamma_{2g}\}$ is a homology basis of said mesh representation.

37. The method of claim 35 wherein the step of computing said conformal parameterization further includes the step of computing a harmonic 1-form basis, wherein the step of computing said harmonic 1-form basis includes the steps of:

calculating the value of $c_i^j = -\gamma_i \bullet \gamma_j$, $i, j = 1, 2, \ldots, 2g$ wherein γ_i, γ_j is the homology basis of the mesh representation respectively; and

solving the linear system $\delta\omega_i = 0$, $\Delta\omega_i = 0$, $\langle\omega_i, \gamma_j\rangle = -\gamma_i \bullet \gamma_j$ for ω_i, wherein $\{\omega_1, \omega_2, \ldots, \omega_{2g}\}$ is the desired harmonic 1-form basis of the mesh representation.

38. The method of claim 36 wherein the step of computing said conformal parameterization further includes the step of computing the fundamental domain D_M of the mesh representation, wherein the step of computing the fundamental domain D_M of the mesh representation includes the steps of:

selecting an arbitrary face, $f_0 \in M$, and set D_M to f_0;

setting $\partial D_m = \partial f_0$;

placing all neighboring faces of f_0 that share an edge with f_0 in a queue, Q;

while Q is not empty:

reading the first face in Q;

setting $\partial f = e_0 + e_1 + e_2$;

setting $D_M = D_M \cup f$;

finding the first $e_i \in \partial f$ such that $-e_i \in \partial D_M$;

replacing $-e_i$ in ∂D_M, respectively, by $\{e_{(i+1)}, e_{(i+2)}\}$;

putting all the neighboring faces that share an edge with f in the mesh representation and that are not in D_M or Q into Q; and

removing all adjacent oriented edges in ∂D_M that are opposite each other in sign.

39. A method for remeshing a mesh representation, M, of a surface, the method comprising the steps of:

a) subdividing the mesh, M, using loop subdivision;

b) simplifying the mesh using edge collapse that uses a minimum edge length criteria.

c) repeat steps a) and b) until all angles on the mesh representation, M, are acute; and

d) outputting the remeshed representation, M, of the surface.

40. A method for converting a mesh representation, M, of a surface, the method comprising the steps of:

receiving the mesh representation, M;

computing a conformal representation of the mesh representation, M;

computing the gradient of the mesh representation, M;

computing the zero points of the mesh representation, M;

decomposing the mesh representation, M, into canonical patches using integration lines along the gradient and through the zero points;

conformally mapping the canonical patches onto a respective rectangle;

constructing a tensor product spline surface on the surface of the rectangle; and

matching the control points on the boundary to make the parameterization globally smooth.

41. The method of claim 39 wherein the mesh representation, M, is discontinuous on the boundaries and wherein the parameterization is continuous on the boundaries.

42. A method for conformally mapping a mesh representation of a scanned medical image, M, of a body part to a canonical surface, the method comprising the steps of:

a) computing the Gauss map, mapping M to S^2;

b) computing the Laplacian at each vertex u of M, $\Delta\phi(u)$;

c) projecting $\Delta\phi(u)$ to the tangent space of $\phi(u) \in S^2$;

d) updating $\phi(u)$ along the negative projected $\Delta\phi(u)$;

e) computing the center of mass of $\phi(u)$, $mc(\phi)$;

f) shifting the center of mass to the center of S^2;

g) renormalizing $\phi(u)$ to be on S^2; and

h) repeating steps b)-g) for all vertices, until the projected Laplacian equals zero.

43. A method for animating a mesh representation, M, of a surface from a first mesh representation, M_1, to a second mesh representation, M_2, the method comprising the steps of:

removing at least one feature point common to both M_1 and M_2;

doubling each of M_1 and M_2;

conformally mapping M_1 and M_2 to first and second canonical surfaces, forming first and second mapped surfaces;

computing a holomorphic 1-form for said first and second mapped surfaces;

computing a cohomology basis of said first and second mapped surfaces;

locating first and second zero points on said first and second mapped surfaces;

computing first and second gradients of said first and second mapped surfaces at said first and second zero points, respectively;

decomposing the first and second mesh representations, M_1 and M_2, into first and second sets of canonical patches using integration lines along the first and second gradients and through the first and second zero points, respectively;

conformally mapping the first and second sets of patches onto first and second rectangles, respectively;

matching said first and second mapped patches on said first and second rectangles to form a map therebetween;

selecting at least one control point on each of said first and second mapped patches on said first and second rectangles; and

using a BSpline to generate a smooth transition of said mapping.

44. A method of texture mapping on a mesh representation, M, representative of a surface, the method comprising the steps of:

removing at least one feature point on M;

doubling M;

conformally mapping M to a canonical surface, forming a mapped surface;

computing a holomorphic 1-form for said mapped surface;

computing a cohomology basis of said mapped surface;

locating zero points on said mapped surface;

computing a gradient of said mapped surface;

decomposing said mesh representation, M, into at least two canonical patches using integration lines along said gradient and through said zero point, respectively;

conformally mapping said at least two canonical patches onto at least two rectangles;

growing said at least two rectangles until respective boundaries between said at least two rectangles meet;

fixing the boundaries between said at least two rectangles; and

solving the Dirichlete problem for the uncovered regions of said at least two rectangles.

45. A method of volumetric harmonic mapping of a mesh representation, M, of a 3-dimensional manifold, the method comprising the steps of:

computing the harmonic energy of a mapping $f : M \to R^3$, where the harmonic energy is given by $E(f) = \sum_{[u,v] \in M} k_{uv} \| f(u) - f(v) \|$ and $k_{uv} = \frac{1}{48} \sum_{\theta} \cot(\theta)$, where θ is the dihedral angle opposite to the given edges;

minimizing the harmonic energy using the conjugate gradient method to obtain the harmonic mapping, f.

46. The method of claim 44 wherein the representation M of the 3-dimensional manifold is a magnetic resonance image of a body area of interest, and wherein the mapping $f : M \to R^3$ is a map onto a canonical sphere of the body area of interest.

47. The method of claim 45 further including using said map onto said canonical sphere of said body area of interest for surgical planning.

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